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INFORMATION SYSTEM ON ILLINOIS COAL II: Characterization of Samples In the Illinois Basin Coal Sample Program

**Richard D. Harvey
Aravinda Kar
John D. Steele**

1986

**Final Report to the Coal Research Board
Illinois Department of Energy and Natural Resources
through the Center for Research on Sulfur in Coal
Contract 1-5-90190**

**Illinois Department of Energy and Natural Resources
STATE GEOLOGICAL SURVEY DIVISION**

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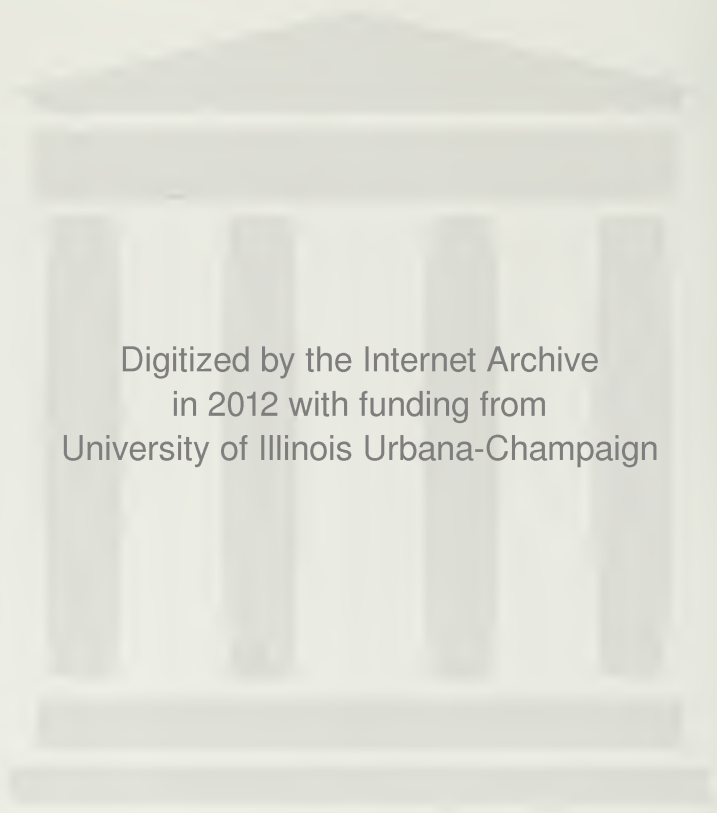
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ABSTRACT	iv
EXECUTIVE SUMMARY	1
INTRODUCTION AND BACKGROUND	3
ACKNOWLEDGMENTS	3
PROCEDURES	3
INFORMATION SYSTEM	5
User access	7
Data acquisition procedure	7
Services to users without a terminal	9
RESULTS OF ANALYSES	9
Standard chemical analyses	9
Minor and trace elements	9
Petrographic analyses	11
Mineralogic analyses	11
SAMPLE USERS	11
REFERENCES	12
FIGURES	
1. Elements for which analytical data were determined	4
2. Design of the IBCSP data base	6
3. Flow chart for IBCSP data base	8
TABLES	
E1. Maceral and reflectance analyses	2
E2. Mineral composition	2
1. Chemical, petrographic, and mineralogic data available	6
2. Statistics for standard chemical results of samples	10
3. Minor and trace elements	13
4. Maceral and reflectance data	14
5. Pyrite characterization and pyrite cleanability index	17
6. Mineral analyses	19
APPENDIX	
Investigators of samples from the Program	22

ABSTRACT

Petrographic, mineralogic, and minor and trace element compositions of the first five samples in the Illinois Basin Coal Sample Program (IBCSP) were determined, and an information system for IBCSP was established on a mainframe computer at the University of Illinois. The information is accessible from remote terminals. Proximate, ultimate and other standard test data were already available on the samples. In addition to these data, the information system includes the name, address, sample number, project title, and results or objectives of each researcher using IBCSP samples. To date 156 uniform splits of the samples have been provided to 48 researchers.

The computerized information system is operational. Persons interested in accessing it from their terminals may arrange to do so by contacting the Illinois State Geological Survey.

EXECUTIVE SUMMARY

Characteristic properties--maceral composition, reflectance of vitrinite, pyrite characterization (including pyrite cleanability index), mineral matter composition, and minor and trace element compositions -- were determined on the samples that are part of the Illinois Basin coal sample program (IBCSP). An informational data base comprising these and other data was established on a mainframe computer at the University of Illinois. Other data include the name, address, sample numbers, project title, and objectives or results of each researcher who is using one or more of the IBCSP samples. At this writing 156 uniform splits of the first four samples in the program have been provided to 48 researchers, 34 located in Illinois, the rest in other states and Canada.

Petrographic analyses show that all samples are vitrinite rich (table E1). Expressed on a mineral matter corrected basis, the vitrinite content ranges from 62.3 to 85.7 and the total inertinite content from 3.9 to 8.8 volume percent.

Mineral matter is most abundant in sample 4 (table E2) because it is a mine-run product, which contains some shale from the mine roof. A trace of marcasite, an orthorhombic form of FeS_2 , was detected in samples 1, 2, 3, and 5. This has importance because marcasite is more prone to oxidize than pyrite and marcasite may affect certain chemical processes more readily than pyrite.

Sample 2, from the Colchester (No. 2) Coal, contains relatively high concentrations of arsenic, germanium, and lead in comparison with the average for these elements in previously analyzed samples from the Herrin (No. 6) and Springfield (No. 5) Coal seams. Arsenic and lead are associated with sulfide minerals and germanium with organic matter in previously tested samples.

Other important characteristics of the IBCSP samples are:

Sam. no.	Product	Seam	Location	Rank	Ash*	S*	PyS/ OrS
1	Prep plant	IL No. 6	W. Central IL	hvCb	10.3	4.3	0.4
2	Prep plant	IL No. 2	Western IL	hvCb	6.7	3.2	2.5
3	Prep plant	80% IL No. 5 20% IL No. 6	Southern IL	hvBb	8.4	2.3	0.9
4	Mine-run	IL No. 6	Southwestern IL	hvCb	38.1	4.2	1.3
5	Channel	IL No. 6	Southwestern IL	hvCb	18.0	4.6	1.2

* Weight percent, dry basis.

Table E1. Maceral and reflectance analyses*

Sample no.	1	2	3	4	5
Maceral analysis, vol. %					
vitritinite	81.8	85.7	81.2	62.3	76.5
Exinite ⁺	2.5	3.5	3.5	2.0	2.2
Resinite	2.7	2.3	1.7	2.4	0.7
Other liptinites	nil	nil	nil	0.1	nil
Micrinite	1.0	0.7	0.3	1.0	0.9
Macrinite & Scl.	0.4	tr	0.2	0.6	1.1
Semifusinite	1.9	1.8	5.8	1.8	3.4
Fusinite	1.2	0.3	0.7	1.8	2.6
Inertodetrinite	1.1	1.2	1.4	1.1	0.7
Pyrite	1.1	2.7	1.0	3.0	1.8
Other minerals	6.2	1.9	4.2	23.9	9.9
Reflectance of vitritinite (telocollinite) (%)					
mean [#]	0.46	0.62	0.74	0.67	0.50
std. dev.	0.043	0.050	0.048	0.054	0.034

* Mineral matter corrected according to the ash and sulfur values by the Parr formula. The rounding of decimals causes some columns not to total 100 %.

⁺ Sporinite and cutinite are grouped together as exinite.

[#] Mean of 100 maximum readings, measured under oil.

Table E2. Mineral composition*

Sample no.	1	2	3	4	5
Mineral matter (low temperature (140°C) ash residue)	13.0	10.0	9.8	43.0	20.9
Quartz	2.6	0.6	1.4	8.0	4.0
Calcite	0.5	2.7	nil	1.6	2.7
Pyrite	2.1	4.0	1.8	4.6	4.2
Kaolinite	3.3	1.0	2.6	6.4	4.1
Illite	2.4	0.8	2.7	9.9	2.5
Expandable	2.1	0.9	1.3	12.5	3.4
Other minerals (detected in minor or trace amounts) ⁺					
Marc	Marc	Marc	Marc	Plag	Marc
Anhy	Coq	Szom	Szom	Szom	Dol
Szom					

* Weight percent of coal sample.

⁺ Anhy - anhydrite (CaSO_4), Coq - Coquimbite ($\text{Fe}_2(\text{SO}_4)_2(\text{OH})_6$)

Marc - marcasite (FeS_2), Plag - plagioclase (silicate)

Szom - szomolnokite ($\text{Fe}_2\text{SO}_4 \cdot \text{H}_2\text{O}$), Dol - dolomite ($\text{CaMg}(\text{CO}_3)_2$)

INTRODUCTION AND BACKGROUND

Much interest has been expressed in the Illinois Basin Coal Sample Program (IBCSPP) by researchers being funded by the Illinois Coal Development Board and other coal research groups within and outside Illinois. The program is directed by Dr. Carl W. Kruse, Illinois State Geological Survey. To help the users of the IBCSP and others, this project was initiated with two objectives:

- 1) determine useful characteristic properties of the samples; and
- 2) establish a computerized information system (data base) for IBCSP on a computer capable of supporting on-line users at remote terminals. The properties determined are various petrographic, mineralogic, and minor and trace element analyses. These data together with the more standard chemical analyses need to be incorporated in the data base. In addition, the data base should include information about the projects being undertaken by users of the samples. This will promote collaboration among users and help them and others plan future projects using these samples.

ACKNOWLEDGMENTS

This work was sponsored by the Illinois Department of Energy and Natural Resources through the Illinois Coal Development Board. Several ISGS staff members assisted in various tasks: Richard A. Cahill, L. Ray Henderson, Lawrence B. Kohlenberger, Donald J. Lowry, and James J. Miner performed the analyses, and O. Michael Dieter assisted with the computer programming.

PROCEDURES

Petrographic data were determined using the following procedures. A representative split (-20 mesh) of each sample was obtained, mounted in epoxy and polished for determination of reflectance and maceral composition. The methods used followed those described in ASTM (1985): D2797 - for preparation of samples, D2798 - for reflectance measurement, and D2799 - for measurement of maceral composition. The microscopic specimens used for these analyses were also used for pyrite characterization which followed the method of Harvey and DeMaris (1985).

The residue from low temperature ashing (LTA) at about 140°C was used as the best quantitative measure of the total mineral matter content of coal (Harvey et al., 1983). The amount of the various mineral phases in the LTA was determined by quantitative X-ray diffraction methods and the results converted to the whole coal basis.

H Hydrogen	He Helium																
Li Lithium	Be Beryllium	Ne Neon															
Na Sodium	Mg Magnesium	Al Aluminum	Si Silicon	P Phosphorus	S Sulfur	Cl Chlorine	Ar Argon										
K Potassium	Ca Calcium	Sc Scandium	Ti Titanium	V Vanadium	Cr Chromium	Mn Manganese	Fe Iron	Co Cobalt	Ni Nickel	Cu Copper	Zn Zinc	Ga Gallium	Ge Germanium	As Arsenic	Se Selenium	Br Bromine	Kr Krypton
Rb Rubidium	Sr Strontium	Y Yttrium	Zr Zirconium	Nb Niobium	Mo Molybdenum	Tc Technetium	Ru Ruthenium	Rh Rhodium	Pd Palladium	Ag Silver	Cd Cadmium	In Indium	Sn Tin	Sb Antimony	Te Tellurium	I Iodine	Xe Xenon
Cs Cesium	Ba Barium	La Lanthanum	Hf Hafnium	Ta Tantalum	W Tungsten	Re Rhenium	Os Osmium	Ir Iridium	Pt Platinum	Au Gold	Hg Mercury	Tl Thallium	Pb Lead	Bi Bismuth	Po Polonium	At Astatine	Rn Radon
Fr Francium	Ra Radium	Ac Actinium															
Ce Cerium	Pr Praseodymium	Nd Neodymium	Pm Promethium	Sm Samarium	Eu Europium	Gd Gadolinium	Tb Terbium	Dy Dysprosium	Ho Holmium	Er Erbium	Tm Thulium	Yb Ytterbium	Lu Lutetium				
Th Thorium	Pa Protactinium	U Uranium	Np Neptunium	Pu Plutonium	Am Americium	Cm Curium	Bk Berkelium	Cf Californium	Es Einsteinium	Fm Fermium	Md Mendelevium	No Nobelium	Lw Lawrencium				

Figure 1. Elements (with dot pattern) for which analytical data were determined.

Concentrations of the minor and trace elements in the samples were determined by the following analytical methods:

Optical emission, photographic-

Ag, B, Be, Ge, Tl, V.

Ion selective electrode-

F

Energy dispersive X-ray-

Ba, Mo, Sn, Sr, Zr.

Wave-length dispersive X-ray-

Al, Ca, Fe, K, P, Si, Ti.

Atomic absorption-

Cd, Cu, Li, Mg, Ni, Pb, Zn.

Instrumental neutron activation-

As, Br, Ce, Co, Cr, Cs, Dy, Eu, Ga, Hf, La, Lu,
Mn, Na, Rb, Sb, Sc, Se, Sm, Ta, Tb, Th, U, W, Yb.

These elements together with those determined as part of the ultimate analysis comprise most of the periodic chart (fig.1). The elements not analyzed either have no stable isotopes (Tc, Pm) or they are of much lesser importance. Bismuth, tellurium, and mercury are of some environmental concern and they, together with some of the other remaining elements, should be considered as part of a future project.

The information system was established on the University of Illinois' Cyber-175 computer, in Urbana. The system provides on-line menu options so that users can easily obtain the desired data. The system was established in parallel with the existing information system on chemistry of Illinois coals (Harvey, et al. 1985). The two data bases are set up so that investigators at remote facilities can access one or both during a computer session.

INFORMATION SYSTEM

The information system was designed to handle two types of data. The first contains the name, address, project title, and results or objectives of the researchers using the samples; the second contains the chemical and other characteristic properties of the samples (fig. 2). These properties are listed in more detail in table 1. The system provides those users who have only a terminal and modem the capability to print data at the ISGS for same day mailing to the user. Those users with a computer and communications software can off-load the data to their own facility.

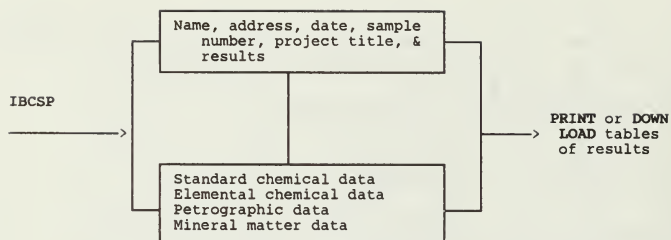


Figure 2. Design of the IBCSP data base.

Table 1. Chemical, petrographic, and mineralogic data available on the coal samples

Standard Chemical Analyses	Minor Elements (reported as oxides)
Proximate analyses	Si, Al, Fe, Mg, Ca, K, Ti, P
Ultimate analyses	Trace Elements
Chlorine	Ag, As, Ba, Be, B, Br, Cd, Ce, Co
Heating value	Cr, Cs, Cu, Dy, Eu, F, Ga, Ge, Hf
Free Swelling Index	La, Li, Lu, Mn, Mo, Na, Ni, Pb, Rb
Gieseler Plasticity	Sb, Sc, Se, Sm, Sn, Sr, Ta, Tb, Th
	Tl, U, V, W, Yb, Zn, Zr
Petrographic Analyses	Mineral Matter Analyses
Maceral analysis	Low Temperature Ash
Reflectance	Pyrite, quartz, calcite, clay
Pyrite Characterization, pyrite cleanability index	Varieties of clay: kaolinite illite, expandable clay (mixed- layered illite/smectite)

User Access

To sign on the computer you must first make telephone connections with the Cyber-175. The telephone number to call depends on the baud rate of your modem:

1-217-333-4000 for 300 baud
1-217-333-4008 for 1200 baud

When telephone connections are established, those using 300 baud need only enter a carriage return <cr>; those using 1200 baud will need to respond to "enter class or help" by entering DNOSA <cr>. The Cyber-175 prompts with "class start", to which you respond with <cr>. On rare occasions all Cyber ports are busy and when this happens, the Cyber gives an opportunity to enter the queue and wait until a port opens. When a port opens, the "READY" prompt is responded to with a <cr>. Don't wait more than 2 or 3 minutes in the queue, but switch off the modem and try again after about 20 minutes. When connection with the Cyber is established, it will prompt for entry of the necessary codes:

You enter*

Note:

SIGNON:	<cr>	Do not
PASSWORD:	<cr>	enter any
RECOVER/CHARGE:	<cr>	spaces

*codes to be provided to users as needed.

You should now be fully logged onto the computer and it prompts for the next entry with a slash, "/".

Data Acquisition Procedure

To start the retrieval program, named IBCSP, enter:

GET,IBCSP/UN=33ISCIC <cr> Note: no spaces are entered
IBCSP <cr>

Further instructions will appear at the terminal screen. A flow chart (fig. 3) summarizes the computer menus and options. The program permits users to read the names of researchers who are using the samples and other related data on the terminal screen, but not the analytical data (fig. 3). However, there is a way to "type" the analytical data to the screen. This can be done by selecting print option 2. This option asks users to give the retrieved file a name--such as the first 6 characters of their institutional name plus a "1" or "2"... This file can then be typed at your screen after you "quit" and get the slash prompt. At that time you enter the sequence given below in item 3.

Sign off the computer by entering "BYE", when prompted with a slash.

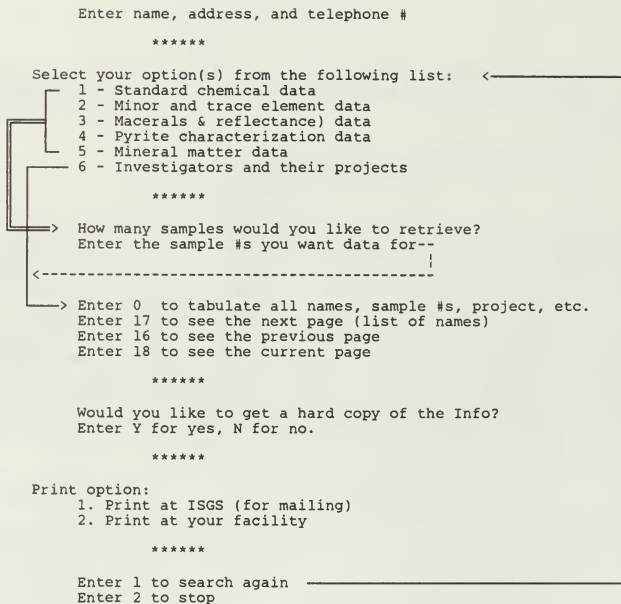


Figure 3. Flow chart for IBCSP data base. Change of terminal screen indicated by *****

If you are connected to the Cyber with only a terminal and want a printed copy of the selected data then print option 1 is selected. This sends a printed copy to the ISGS and it will be mailed to you the same day. If you are connected to the Cyber with a computer and communications software you may off-load the selected data to your own computer by selecting print option 2. You will then be asked to enter a name for the file. You then quit the program and, after the slash prompt is obtained, do the following:

1. Set up your printer to receive the data.
The standard chemical and elemental data sets require the printer to print 132 characters per line.
2. Set up your computer so that whatever is typed on your video terminal is echoed to your printer and/or saved on disk.
3. Enter the following (on the Cyber):

GET,filename <cr>	Note: this is the
PACK,filename<cr>	filename assigned
TYPE,filename<cr>	earlier in IBCSP

After the listing is completed and you select the quit option, you may then sign off the computer by entering "BYE".

Service to Users Without Terminals

Persons without terminals can obtain information free of charge by contacting either the Coal Section or the Minerals Engineering Section of the Illinois State Geological Survey (217/344-1481) or the Center for Research on Sulfur in Coal (217/333-9241), both located in Champaign, Illinois.

RESULTS OF ANALYSES

Standard Chemical Analyses

The results of standard chemical analyses were determined for another project by analysts in the Minerals Engineering Section of the ISGS. We set up these results in a special computer file and wrote a program to provide the mean and typical range on an as-received basis (table 2). The ratio of pyritic to organic sulfur varies among the samples in the sample number order: 2 > 4 > 5 > 3 > 1 (see executive summary). The rank of each sample is high volatile C bituminous, except for sample 3 which is high volatile B.

Minor and Trace Elements

The concentration of the minor and trace elements in the samples is given in table 3. Comparison of the results with the average for the main commercial seams in Illinois indicates sample 4 is

Table 2. Statistics for standard chemical results of samples analyzed on an as received basis

	ANALYSIS	NO. OF SAMPLES	MEAN	TYPICAL RANGE	
Sample 1	MOIS	4	14.1	13.5	14.7
	VOL	3	37.4	37.1	37.7
	FXC	3	39.6	39.3	39.9
	ASH	4	8.9	8.4	9.3
	PYS	3	.97	.81	1.12
	ORS	3	2.43	2.38	2.49
	SUS	1	.10	.10	.10
	TOS	3	3.53	3.48	3.59
	CL	2	.09	.09	.09
	BTU	3	10843	10784	10901
	H	1	5.8	5.8	5.8
	C	1	58.9	58.9	58.9
	N	1	.9	.9	.9
	O	1	22.3	22.3	22.3
Sample 2	MOIS	4	13.5	12.9	14.0
	VOL	3	36.7	36.1	37.3
	FXC	3	43.8	43.1	44.4
	ASH	4	5.9	5.7	6.0
	PYS	3	1.83	1.63	2.04
	ORS	3	.73	.68	.79
	SUS	1	.20	.20	.20
	TOS	3	2.70	2.60	2.80
	CL	NO DATA			
	BTU	3	11739	11665	11813
	H	1	5.9	5.9	5.9
	C	1	62.7	62.7	62.7
	N	1	1.0	1.0	1.0
	O	1	21.8	21.8	21.8
Sample 3	MOIS	4	5.3	5.2	5.5
	VOL	3	37.5	36.7	38.2
	FXC	3	49.3	48.5	50.0
	ASH	4	7.9	7.7	8.0
	PYS	3	.90	.90	.90
	ORS	3	1.07	1.01	1.12
	SUS	1	.10	.10	.10
	TOS	3	2.10	2.10	2.10
	CL	3	.15	.13	.17
	BTU	4	12770	12706	12834
	H	2	5.2	5.2	5.2
	C	2	70.3	69.2	71.4
	N	2	1.5	1.4	1.5
	O	2	12.9	11.6	14.1
Sample 4	MOIS	4	9.9	9.2	10.6
	VOL	3	27.7	27.0	28.4
	FXC	3	27.9	27.3	28.5
	ASH	4	34.3	34.0	34.6
	PYS	4	2.23	1.99	2.46
	ORS	4	1.40	1.13	1.67
	SUS	1	.20	.20	.20
	TOS	4	3.80	3.51	4.09
	CL	4	.05	.02	.08
	BTU	3	7612	7575	7649
	H	3	4.0	4.0	4.0
	C	3	42.6	41.8	43.4
	N	3	.6	.5	.7
	O	3	14.5	13.3	15.7
Sample 5	MOIS	11	9.4	9.1	9.8
	VOL	11	36.6	36.2	37.0
	FXC	11	37.7	37.2	38.3
	ASH	11	16.3	16.0	16.5
	PYS	11	2.21	2.10	2.32
	ORS	11	1.75	1.54	1.97
	SUS	NO DATA			
	TOS	11	4.03	3.86	4.20
	CL	2	.06	.03	.08
	BTU	11	10429	10399	10459
	H	2	4.9	4.8	4.9
	C	2	56.7	54.9	58.5
	N	2	1.0	1.0	1.0
	O	2	17.1	15.1	19.0

notably rich in SiO_2 , MgO , Na_2O , F , and Rb . The reason for these high values is the relatively high abundance of mineral matter in this mine-run sample. It should also be noted that sample 2 contains a relatively high amount of As , Ge , and Pb in comparison with the average for Illinois (table 3). Germanium is probably associated with the organic matter in the sample, while As and Pb are probably associated together in grains of pyrite.

Petrographic Analyses

The results of maceral and reflectance analyses of the samples are given in table 4. On a mineral free basis, all are distinctly rich in vitrinite (85.3 to 89.9 vol. %). On this basis, sample 5 is most enriched in inertinite group macerals (10.0 vol. %). The mean maximum reflectance of the samples ranges from 0.46 to 0.74 percent, sample 1 being the lowest and sample 3 the highest. The reflectance results are consistent with the rank of the coals as noted above. Note: the format of table 4, as well as the remaining ones, is essentially the same as the format of the tabulated data that is printed from IBCSP.

The results of pyrite characterization are given in table 5, which comprises quantitative data on the mean size and maceral/mineral association of pyrite grains and the pyrite cleanability index (PCI) for each sample (Harvey and DeMaris, 1985). The mean diameter of pyrite ranges from $4.2\text{ }\mu\text{m}$ (sample 3) to $8.72\text{ }\mu\text{m}$ (sample 4). The results also show a wide range of PCI values for these two samples: 0.25 to 2.19. This index is very much a function of particle size due to increased liberation of pyrite during fine grinding. However, as all the reported values were determined on -20 mesh samples, they can be used to compare the samples one to the other. The PCI data indicate a higher percentage of the pyrite in sample 4 can be cleaned (removed) from this sample than from sample 3 without further grinding. This is consistent with the fact that sample 3 is a product from a preparation plant while sample 4 is a mine-run product. The high PCI for sample 4 is due to the large percentages of free pyrite and pyritic coal in this sample as compared to the others. Sample 5 tested to have the highest index (2.96).

Mineralogic Analyses

The results of mineral analyses are given in table 6. The mine-run sample (sample 4) contains the highest amount of mineral matter (43%). Kaolinite is the predominant clay mineral in samples 1, 2, and 5; and both kaolinite and illite are about equal in abundance in sample 3. The expandable clay mineral, also known as mixed-layered illite/smectite, is most abundant in sample 4.

SAMPLE USERS

The name, address, sample number, project title, and results or objectives of the research work of each of the investigators of IBCSP samples are given in the appendix.

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Table 3. Minor and trace elements

	IBCSP sample number					Average [*] IL coal
Oxide/element	1	2	3	4	5	
Minors (%)						
SiO ₂	4.6	1.8	4.1	22.1	8.2	5.5
Al ₂ O ₃	1.6	0.9	1.8	6.5	2.9	2.5
Fe ₂ O ₃	1.7	2.8	1.5	3.8	3.4	2.7
MgO	0.09	0.038	0.073	0.529	0.185	0.046
CaO	0.5	0.2	0.1	1.4	1.2	1.0
Na ₂ O	0.139	0.0182	0.0297	0.337	0.168	0.0987
K ₂ O	0.21	0.11	0.2	0.99	0.33	0.22
P ₂ O ₅	0.02	0.01	0.03	0.09	0.02	0.02
TiO ₂	0.08	0.03	0.09	0.31	0.15	0.11
Traces (ppm)						
Ag	<1	<1	<1	<1	<0.2	0.06
As	2	32	16	5	2.6	11
Ba	32	14	28	135	73	140
Be	1.4	3.3	1.2	2.7	1.0	1.5
B	193	109	71	317	179	118
Br	6	3	12	3	6.5	12
Cd	1.1	0.8	0.1	<0.4	-	1.5
Ce	6	2	10	21	19	14.7
Co	3	6	5	9	3.8	5
Cr	31	7	16	44	19	18
Cs	1.1	0.8	1.2	4	1.9	1.0
Cu	9.7	21.9	8.0	14.4	9.5	12.5
Dy	0.6	1.5	0.9	1.7	-	1.1
Eu	0.2	0.2	0.2	0.5	0.2	0.3
F	63	26	56	460	-	68
Ga	3	3	3	10	3.4	3.9
Ge	<5	30	<5	<5	5	5
Hf	0.4	0.2	0.5	1.7	1.0	0.6
La	4	2	7	16	5.9	7
Li	11.3	18.1	29.9	38.9	8.2	16.3
Lu	0.1	0.1	0.1	0.3	0.08	0.1
Mn	31	16	13	112	71	55
Mo	15	4	13	6	9	9
Ni	11	22	14	23	15	18
Pb	8	149	57	28	6	28
Rb	9	5	11	63	20	16
Sb	0.2	3.4	1.1	0.3	0.3	1.0
Sc	2.1	2.1	2.6	6.4	2.4	2.7
Se	1.5	1.3	2.2	2.2	2.4	2.4
Sm	0.9	0.9	1.4	2.9	1.2	1.4
Sn	<1	<1	<1	1.7	<5	-
Sr	25	12	33	58	29	34
Ta	0.1	0.1	0.1	0.4	0.25	0.2
Tb	0.1	0.2	0.2	0.2	0.13	0.2
Th	1.2	0.7	1.3	3.9	3.2	2.2
Tl	<2	<2	<2	<2	1.0	1.0
U	<2	<1.5	<4	<3	1.2	1.5
V	25	22	26	50	23	31
W	<0.5	<0.5	<0.7	0.9	1.5	0.6
Yb	0.4	0.6	0.5	1.0	0.5	0.6
Zn	172	99.8	45.1	175	77	248
Zr	16	13	23	51	28	35

* Calculated from data on channel samples from the Herrin (No.6) and Springfield (No. 5) Coals (Harvey, et al., 1983).

Table 4. Maceral and reflectance (mean, standard deviation for vitrinite) data

SAMPLE NO. IBCSP-1 SEAM: HERRIN (NO.6) LAB. NO. C22542
 LOCATION: WEST CENTRAL ILLINOIS SAMPLE COLLECTED BY MDS, 6-15-83
 SAMPLE TYPE: RUN OF PREPARATION PLANT

MACERAL/MINERAL	VOLUME PERCENT		
	MEASURED	MINERAL CORRECTED	MINERAL FREE
TOTAL VITRINITE	85.9	81.8	88.3
EXINITE	2.6	2.5	2.7
RESINITE	2.8	2.7	2.9
OTHER LIPTINITE	nil	nil	nil
TOTAL LIPTINITE	5.4	5.1	5.5
MICRINITE	1.1	1.0	1.1
MACRINITE/SCLEROTINITE	0.4	0.4	0.4
SEMIFUSINITE	2.0	1.9	2.1
FUSINITE	1.3	1.2	1.3
INERTODETRINITE	1.2	1.1	1.2
TOTAL INERTINITE	6.0	5.7	6.2
PYRITE	1.1	1.1	
OTHER MINERALS	1.6	6.2	
CALCITE OBSERVED (Y OR N)	N		
OTHER SULFIDES OBSERVED (Y OR N)	N		
TOTAL COUNT: 1000			
REFLECTANCE, VITRINITE (TELOCOLLINITE):	0.46 %	(MEAN OF 100 MAXIMUM	
STANDARD DEVIATION:	0.043 %	READINGS UNDER OIL)	

ASH: 10.9% TOTAL SULFUR: 4.19% (DRY BASIS)
 ANALYST: JJM, DATE OF ANALYSIS: 12-31-85, PROJECT: IBCSP
 DESCRIPTION: MACRINITE = 0.2%, SCLEROTINITE = 0.2% (AS MEASURED)

SAMPLE NO. IBCSP-2 SEAM: COLCHESTER (NO.2) LAB. NO. C22543
 LOCATION: WESTERN ILLINOIS SAMPLE COLLECTED BY MDS, 7-10-83
 SAMPLE TYPE: RUN OF PREPARATION PLANT

MACERAL/MINERAL	VOLUME PERCENT		
	MEASURED	MINERAL CORRECTED	MINERAL FREE
TOTAL VITRINITE	86.9	85.7	89.9
EXINITE	3.5	3.5	3.6
RESINITE	2.3	2.3	2.4
OTHER LIPTINITE	nil	nil	nil
TOTAL LIPTINITE	5.8	5.7	6.0
MICRINITE	0.7	0.7	0.7
MACRINITE/SCLEROTINITE	tr	tr	tr
SEMIFUSINITE	1.8	1.8	1.9
FUSINITE	0.3	0.3	0.3
INERTODETRINITE	1.2	1.2	1.2
TOTAL INERTINITE	4.0	3.9	4.1
PYRITE	2.7	2.7	
OTHER MINERALS	0.6	1.9	
CALCITE OBSERVED (Y OR N)	N		
OTHER SULFIDES OBSERVED (Y OR N)	N		
TOTAL COUNT: 1000			
REFLECTANCE, VITRINITE (TELOCOLLINITE):	0.62 %	(MEAN OF 100 MAXIMUM	
STANDARD DEVIATION:	0.050 %	READINGS UNDER OIL)	

ASH: 6.8% TOTAL SULFUR: 3.17% (DRY BASIS)
 ANALYST: JJM, DATE OF ANALYSIS: 01-03-86, PROJECT: IBCSP
 DESCRIPTION: BOTH MACRINITE AND SCLEROTINITE WERE OBSERVED IN TRACE AMOUNTS. ISGS

Table 4. (Continued)

SAMPLE NO. IBCSP-3 SEAM: SEE NOTE LAB. NO. C22544
 LOCATION: SOUTHERN ILLINOIS SAMPLE COLLECTED BY MDS, 11-08-83
 SAMPLE TYPE: RUN OF PREPARATION PLANT

NOTE: 80% SPRINGFIELD (NO.5) AND 20% HERRIN (NO.6) SEAMS

DATA SET: C22544.A2P	VOLUME PERCENT		
	MEASURED	MINERAL CORRECTED	MINERAL FREE
MACERAL/MINERAL			
TOTAL VITRINITE	84.6	81.2	85.7
EXINITE	3.6	3.5	3.6
RESINITE	1.8	1.7	1.8
OTHER LIPTINITE	nil	nil	nil
TOTAL LIPTINITE	5.4	5.2	5.5
MICRINITE	0.3	0.3	0.3
MACRINITE/SCLEROTINITE	0.2	0.2	0.2
SEMIFUSINITE	6.0	5.8	6.1
FUSINITE	0.7	0.7	0.7
INERTODETRINITE	1.5	1.4	1.5
TOTAL INERTINITE	8.7	8.4	8.8
PYRITE	1.0	1.0	
OTHER MINERALS	0.3	4.2	
CALCITE OBSERVED (Y OR N)	N		
OTHER SULFIDES OBSERVED (Y OR N)	N		
TOTAL COUNT: 1000			
REFLECTANCE, VITRINITE (TELOCOLLINITE):	0.74 %	(MEAN OF 100 MAXIMUM	
STANDARD DEVIATION:	0.048 %	READINGS UNDER OIL)	

ASH: 8.4% TOTAL SULFUR: 2.19% (DRY BASIS)
 ANALYST: JJM, DATE OF ANALYSIS: 01-05-86, PROJECT: IBSCP
 DESCRIPTION: NO SCLEROTINITE WAS OBSERVED

SAMPLE NO. IBCSP-4 SEAM: HERRIN (NO.6) LAB. NO. C22545
 LOCATION: SOUTHWESTERN ILLINOIS SAMPLE COLLECTED BY JMB, 12-15-83
 SAMPLE TYPE: RUN OF MINE

DATA SET: C22545.A2P	VOLUME PERCENT		
	MEASURED	MINERAL CORRECTED	MINERAL FREE
MACERAL/MINERAL			
TOTAL VITRINITE	65.2	62.3	85.3
EXINITE	2.1	2.0	2.7
RESINITE	2.5	2.4	3.3
OTHER LIPTINITE	0.1	0.1	0.1
TOTAL LIPTINITE	4.7	4.5	6.2
MICRINITE	1.0	1.0	1.3
MACRINITE/SCLEROTINITE	0.6	0.6	0.8
SEMIFUSINITE	1.9	1.8	2.5
FUSINITE	1.9	1.8	2.5
INERTODETRINITE	1.1	1.1	1.4
TOTAL INERTINITE	6.5	6.2	8.5
PYRITE	3.0	3.0	
OTHER MINERALS	20.6	23.9	
CALCITE OBSERVED (Y OR N)	Y		
OTHER SULFIDES OBSERVED (Y OR N)	N		
TOTAL COUNT: 1000			
REFLECTANCE, VITRINITE (TELOCOLLINITE):	0.67 %	(MEAN OF 100 MAXIMUM	
STANDARD DEVIATION:	0.054 %	READINGS UNDER OIL)	

ASH: 38.1% TOTAL SULFUR: 3.91% (DRY BASIS)
 ANALYST: JJM, DATE OF ANALYSIS: 04-19-85, PROJECT: IBSCP
 DESCRIPTION: SCLEROTINITE=0.2% (AS MEASURED); OTHER LIPTINITE=FLUORINITE
 ISGS

Table 4. (Continued)

SAMPLE NO. IBCSP-5 SEAM: HERRIN (NO.6) LAB. NO. C25189
 LOCATION: SOUTHWESTERN ILLINOIS SAMPLE COLLECTED BY RDH, 12-03-85
 SAMPLE TYPE: CHANNEL OF SEAM; IMPURITIES >3/8" PRESENT IN SAMPLE
 NOTE: 3-TON CHANNEL EXCLUSIVE OF 6"@ TOP & BOTTOM; N-SEALED BY ARGONNE NAT.L.

MACERAL/MINERAL	VOLUME PERCENT		
	MEASURED	MINERAL CORRECTED	MINERAL FREE
TOTAL VITRINITE	81.8	76.5	86.7
EXINITE	2.4	2.2	2.5
RESINITE	0.8	0.7	0.8
OTHER LIPTINITE	nil	nil	nil
TOTAL LIPTINITE	3.2	3.0	3.4
MICRINITE	1.0	0.9	1.1
MACRINITE/SCLEROTINITE	1.2	1.1	1.3
SEMIFUSINITE	3.6	3.4	3.8
FUSINITE	2.8	2.6	3.0
INERTODETRINITE	0.8	0.7	0.8
TOTAL INERTINITE	9.4	8.8	10.0
PYRITE	1.8	1.8	
OTHER MINERALS	3.8	9.9	
CALCITE OBSERVED (Y OR N)	Y		
OTHER SULFIDES OBSERVED (Y OR N)	N		
TOTAL COUNT:	500		
REFLECTANCE, VITRINITE (TELOCOLLINITE):	0.50 %	(MEAN OF 100 MAXIMUM	
STANDARD DEVIATION:	0.034 %	READINGS UNDER OIL)	

ASH: 17.8% TOTAL SULFUR: 4.27% (DRY BASIS)
 ANALYST: JJM, DATE OF ANALYSIS: 08-13-86, PROJECT: IBCSP
 DESCRIPTION: MACRINITE = 0.6%, SCLEROTINITE = 0.6% (AS MEASURED)

ISGS

Table 5. Pyrite characterization and pyrite cleanability index

SAMPLE NO. IBCSP-1		SEAM: HERRIN (NO. 6)	LAB NO: C22542.P	
LOCATION: WEST CENTRAL ILLINOIS			ANALYSIS DATE: 04/18/86	
SAMPLE TYPE: RUN OF PREPARATION PLANT			PARTICLE SIZE: -20 MESH	
RESULTS FOR PYRITIC GRAINS				
PARTICLE TYPE *	NO. OF GRAINS	MEAN DIAMETER (μM)	% DIAMETER	% DIAMETER (V,I,T BASIS)
VITRITE	225	5.00	38.36	56.25
INERTITE	0	-	-	-
TRIMACERITE	175	5.00	29.83	43.75
CARBOMINERITE	48	8.94	14.63	
PYRITIC COAL	23	13.83	10.85	
FREE PYRITE	29	6.40	6.33	
TOTAL	500	5.87	100.0	
PYRITE CLEANABILITY INDEX: 0.47				

SAMPLE NO. IBCSP-2		SEAM: COLCHESTER (NO. 2)	LAB NO: C22543.P	
LOCATION: WESTERN ILLINOIS			ANALYSIS DATE: 04/21/86	
SAMPLE TYPE: RUN OF PREPARATION PLANT			PARTICLE SIZE: -20 MESH	
RESULTS FOR PYRITIC GRAINS				
PARTICLE TYPE *	NO. OF GRAINS	MEAN DIAMETER (μ M)	% DIAMETER	% DIAMETER (V,I,T BASIS)
VITRITE	197	4.50	34.77	54.18
INERTITE	1	2.41	0.09	0.14
TRIMACERITE	160	4.67	29.31	45.68
CARBOMINERITE	97	6.46	24.58	
PYRITIC COAL	17	11.34	17.56	
FREE PYRITE	28	3.36	3.69	
TOTAL	500	5.10	100.0	
PYRITE CLEANABILITY INDEX: 0.56				

*THE COMPOSITION OF PYRITE BEARING PARTICLES ARE DISTINGUISHED AS FOLLOWS:
 VITRITE = >95% VITRINITE; INERTITE = >95% INERTINITE;
 TRIMACERITE = >95% OF 2 OR 3 DIFFERENT GROUP MACERALS;
 CARBOMINERITE = 5-20% PYRITE OR 20-60% CLAY, QUARTZ, AND CALCITE;
 PYRITIC COAL = 20-95% PYRITE; FREE PYRITE = >95% PYRITE (LIBERATED).
 NOTE: TRACES OF PYRITE IN LIPTITE (IF ANY) IS ADDED TO VITRITE.

ISGS

Table 5. (Continued)

SAMPLE NO. IBCSP-3 SEAM: SEE NOTE LAB NO: C22544.P
 LOCATION: SOUTHERN ILLINOIS ANALYSIS DATE: 04/22/86
 SAMPLE TYPE: RUN OF PREPARATION PLANT PARTICLE SIZE: -20 MESH

NOTE: 80% SPRINGFIELD (NO.5) AND 20% HERRIN (NO.6) SEAMS

RESULTS FOR PYRITIC GRAINS

PARTICLE TYPE *	NO. OF GRAINS	MEAN DIAMETER (μ M)	% DIAMETER	% DIAMETER (V,I,T BASIS)
VITRITE	222	4.15	42.99	53.67
INERTITE	0	-	-	-
TRIMACERITE	193	4.12	37.10	46.33
CARBOMINERITE	71	4.99	16.53	
PYRITIC COAL	1	4.82	0.22	
FREE PYRITE	13	5.19	3.16	
TOTAL	500	4.28	100.0	

PYRITE CLEANABILITY INDEX: 0.25

SAMPLE NO. IBCSP-4 SEAM: HERRIN (NO. 6) LAB NO: C22545.JJM
 LOCATION: SOUTHWESTERN ILLINOIS ANALYSIS DATE: 04/22/86
 SAMPLE TYPE: RUN OF MINE PARTICLE SIZE: -20 MESH

RESULTS FOR PYRITIC GRAINS

PARTICLE TYPE *	NO. OF GRAINS	MEAN DIAMETER (μ M)	% DIAMETER	% DIAMETER (V,I,T BASIS)
VITRITE	86	5.86	8.25	26.32
INERTITE	4	4.82	0.32	1.01
TRIMACERITE	193	7.21	22.77	72.67
CARBOMINERITE	167	9.77	26.71	
PYRITIC COAL	39	25.40	16.22	
FREE PYRITE	211	7.45	25.73	
TOTAL	700	8.72	100.0	

PYRITE CLEANABILITY INDEX: 2.19

SAMPLE NO. IBCSP-5 SEAM: HERRIN (NO.6) LAB NO: C25189.D
 LOCATION: SOUTHWESTERN ILLINOIS ANALYSIS DATE: 8-15-86
 SAMPLE TYPE: CHANNEL PARTICLE SIZE: -20 MESH
 NOTE: 3-TON CHANNEL EXCLUSIVE OF 6 " @ TOP & BOTTOM; N - SEALED AT MINE
 BY ARGONNE NATIONAL LABORATORY

RESULTS FOR PYRITE GRAINS

PARTICLE TYPE *	NO. OF GRAINS	MEAN DIAMETER (μ M)	% DIAMETER	% DIAMETER (V,I,T BASIS)
VITRITE	123	4.25	13.96	55.33
INERTITE	1	14.46	0.39	1.55
TRIMACERITE	91	4.48	10.88	43.12
CARBOMINERITE	17	8.65	3.93	
PYRITIC COAL	63	17.98	30.24	
FREE PYRITE	205	7.42	40.60	
TOTAL	500	7.49	100.0	

PYRITE CLEANABILITY INDEX: 2.96

Table 6. Mineral analyses of coal samples

SAMPLE NO. IBCSP-1 SEAM: HERRIN (NO.6) LAB. NO. C22542
 LOCATION: WEST CENTRAL ILLINOIS COLLECTED BY MDS 6-15-83
 SAMPLE TYPE: RUN OF PREPARATION PLANT

RESULTS (WEIGHT % BY LOW TEMP. ASHING)

ORGANIC MATTER: 87.0

MINERAL MATTER: 13.0

MINERAL COMPOSITION (% OF SAMPLE BY X-RAY DIFFRACTION)

QUARTZ : 2.6

CALCITE : 0.5

PYRITE : 2.1
(BY CHEMISTRY)PYRITE : 1.7
(BY X-RAY DIFF.)CLAY : 7.8
(BY DIFFERENCE)

VARIETIES OF CLAY MINERALS (% OF SAMPLE)

KAOLINITE : 3.3

ILLITE : 2.4

EXPANDABLE : 2.1

OTHER MINERALS DETECTED: MINOR - MARCASITE
TRACE - ANHYDRITE & SZOMOLNOKITE

ANALYST: DJL, DATE OF ANALYSIS: 04-15-86, PROJECT: IBCSP

SAMPLE NO. IBCSP-2 SEAM: COLCHESTER (NO.2) LAB. NO. C22543
 LOCATION: WESTERN ILLINOIS COLLECTED BY MDS, 7-10-83
 SAMPLE TYPE: RUN OF PREPARATION PLANT

RESULTS (WEIGHT % BY LOW TEMP. ASHING)

ORGANIC MATTER: 90.0

MINERAL MATTER: 10.0

MINERAL COMPOSITION (% OF SAMPLE BY X-RAY DIFFRACTION)

QUARTZ : 0.6

CALCITE : 2.7

PYRITE : 4.0
(BY CHEMISTRY)PYRITE : 2.7
(BY X-RAY DIFF.)CLAY : 2.7
(BY DIFFERENCE)

VARIETIES OF CLAY MINERALS (% OF SAMPLE)

KAOLINITE : 1.0

ILLITE : 0.8

EXPANDABLE: 0.9

OTHER MINERALS DETECTED: MINOR - MARCASITE & COQUIMBITE

ANALYST: DJL, DATE OF ANALYSIS: 04-15-86, PROJECT: IBCSP

Table 6. (Continued)

SAMPLE NO. IBSCP-3 SEAM: SEE NOTE LAB. NO. C22544
 LOCATION: SOUTHERN REGION OF ILLINOIS COLLECTED BY MDS 11-08-83
 SAMPLE TYPE: RUN OF PREPARATION PLANT

NOTE: 80% SPRINGFIELD (NO.5) AND 20% HERRIN (NO.6) SEAMS

RESULTS (WEIGHT % BY LOW TEMP. ASHING)

ORGANIC MATTER: 90.2

MINERAL MATTER: 9.8

MINERAL COMPOSITION (% OF SAMPLE BY X-RAY DIFFRACTION)

QUARTZ : 1.4

CALCITE : NIL

PYRITE : 1.8 PYRITE : 1.4
 (BY CHEMISTRY) (BY X-RAY DIFF.)

CLAY : 6.6
 (BY DIFFERENCE)

VARIETIES OF CLAY MINERALS (% OF SAMPLE)

KAOLINITE : 2.6

ILLITE : 2.7

EXPANDABLE : 1.3

OTHER MINERALS DETECTED: MINOR - MARCASITE
 TRACE - SZOMOLNOKITE

ANALYST: DJL, DATE OF ANALYSIS: 04-15-86, PROJECT: IBSCP

SAMPLE NO. IBSCP-4 SEAM: HERRIN (NO.6) LAB. NO. C22545
 LOCATION: SOUTHWESTERN ILLINOIS COLLECTED BY JMB, 12-15-83
 SAMPLE TYPE: RUN OF MINE

RESULTS (WEIGHT % BY LOW TEMP. ASHING)

ORGANIC MATTER: 57.0

MINERAL MATTER: 43.0

MINERAL COMPOSITION (% OF SAMPLE BY X-RAY DIFFRACTION)

QUARTZ : 8.0

CALCITE : 1.6

PYRITE : 4.6 PYRITE : 3.1
 (BY CHEMISTRY) (BY X-RAY DIFF.)

CLAY : 28.8
 (BY DIFFERENCE)

VARIETIES OF CLAY MINERALS (% OF SAMPLE)

KAOLINITE : 6.4

ILLITE : 9.9

EXPANDABLE : 12.5

OTHER MINERALS DETECTED: MINOR - SZOMOLNOKITE
 TRACE - PLAGIOCLASE

ANALYST: DJL, DATE OF ANALYSIS: 04-15-86, PROJECT: IBSCP

Table 6. (Continued)

SAMPLE NO. IBCSP-5 SEAM: HERRIN (NO.6) LAB. NO. C25189
 LOCATION: SOUTHWESTERN ILLINOIS COLLECTED BY RDH 12-03-83
 SAMPLE TYPE: CHANNEL OF SEAM; IMPURITIES >3/8 " PRESENT IN THE SEAM

NOTE: 3-TON CHANNEL EXCLUSIVE OF 6" AT TOP & BOTTOM; N-SEALED BY
 ARGONNE NATIONAL LABORATORY

RESULTS (WEIGHT % BY LOW TEMP. ASHING)

ORGANIC MATTER: 79.1

MINERAL MATTER: 20.9

MINERAL COMPOSITION (% OF SAMPLE BY X-RAY DIFFRACTION)

QUARTZ : 4.0

CALCITE : 2.7

PYRITE : 4.2
 (BY CHEMISTRY)

PYRITE : 3.0
 (BY X-RAY DIFF.)

CLAY : 10.0
 (BY DIFFERENCE)

VARIETIES OF CLAY MINERALS (% OF SAMPLE)

KAOLINITE : 4.1

ILLITE : 2.5

EXPANDABLE : 3.4

OTHER MINERALS DETECTED: MINOR - MARCASITE
 TRACE - DOLOMITE

ANALYST: DJL, DATE OF ANALYSIS: 07-30-86, PROJECT: IBSCP

Appendix. Investigators of samples from the Illinois Basin Coal Sample Program

ALBAL, RAJ ISGS, CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)

01180800 71984

PROJECT TITLE:

LOW TEMPERATURE CHARRING.

CONTACT: M. STEPHENSON DR D. RAPP AT ISGS, CHAMPAIGN, IL

ATHERTON, LINDA EPRI, 3412 HILLVIEW AVE, PALO ALTO, CA 94303

SAMPLE # DATE(MM/DD/YR)

01181200 082885 SAMPLE FORWARDED TO BARRY WILSON, BATTELLE, RICHAND, WA

PROJECT TITLE:

MICROBIAALLY INDUCED SPONTANEOUS COMBUSTION

ATWOOD, J CHEMISTRY, UNIV. ALABAMA, UNIVERSITY, AL 35486

SAMPLE # DATE(MM/DD/YR)

02160407 082885

03160407 082885

04030613 082885 ONE 1 LB BAG

PROJECT TITLE:

LIQUEFACTION UNDER AMBIENT CONDITIONS

BRADEN, H. POLYBAC CORP., 954 MARCON BLVD, ALLENTOWN, PA 18103

SAMPLE # DATE(MM/DD/YR)

01 102284 1 LB BAG

02 102284 1 LB BAG

03 102284 1 LB BAG

04 102284 1 LB BAG

PROJECT TITLE:

DESULFURIZATION WITH BACTERIA.

NOTE: ILLINOIS COAL WAS NEVER USED. THEY USED SOME PENNSYLVANIA COAL ACQUIRED THROUGH PENN. STATE UNIV.

CONTACT: C. S. MCDOWELL, POLYBAC CORP. AT THE ABOVE ADDRESS.

BRUCHNER, A. UNIVERSAL OIL PROD., 10 UOP PLAZA, DES PLAINES, IL 60016

SAMPLE # DATE(MM/DD/YR)

01180700 032284

03160600 032284

04030300 032884 ONE 20 LB BAG

PROJECT TITLE:

BRUCHNER HAS MOVED FROM UOP; NO ONE ELSE NAMED.

BUCHANAN, D. H. CHEMISTRY DEPT, EASTERN IL UNIV., CHARLESTON, IL 61920

SAMPLE # DATE(MM/DD/YR)

02160415 061785

04030604 061785

PROJECT TITLE:

CHEMICAL CHARACTERIZATION OF ILLINOIS COAL

RESULTS: LOW TEMPERATURE AIR OXIDATION OF COALS IN THE IBSCP RENDER THEM LESS SOLUBLE IN PYRIDINE, THF AND OTHER SOLVENTS. THE PYRIDINE SOLUBLE, TOLUENE INSOLUBLE FRACTIONS (TIPS) BECOME PARTIALLY INSOLUBLE UPON OXIDATION. CHANGES IN FT-IR SPECTRA, SOLVENT SWELLING, GPC TRACES OF SOLUBLE FRACTIONS, PHENOL OH CONTENT AND ELEMENTAL ANALYSES ARE CONSISTENT WITH THE VIEW THAT THE PYRIDINE SOLUBLE FRACTION OF THESE COALS IS A PHENOL RICH MATERIAL WHICH IS HYDROGEN BONDED TO THE INSOLUBLE COAL RESIDUE AND WITHIN ITSELF.

CHAVEN, C. ISGS, 615 E. PEABODY DR., CHAMPAIGN, IL 61820.

SAMPLE # DATE(MM/DD/YR)

02160516 030585

02160513 030585

PROJECT TITLE:

ELEMENTAL S, SO₄; TRANSFORMATION OF PYRITE TO S & SO₄; CL,BR,F,P

OBJECTIVES: ATTEMPT WILL BE MADE TO DEVISE A NEW SULFUR FRACTIONATION PROCEDURE FOR COAL AND ITS PYROLYTIC PRODUCTS - NAMELY CHAR, AND POSSIBLY OTHER TREATMENTS SUCH AS EXPLOSIVE SHATTERING TECHNIQUE, SUPER CRITICAL EXTRACTION ETC.

CHOU, J. ISGS, 615 E. PEABODY DR., CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)

01120416 040286 ONE 1- BAG

02160716 040286 ONE 1- BAG

03141516 040286 ONE 1- BAG

04051316 040286 ONE 1- BAG

PROJECT TITLE:

EFFICIENCY OF SULFUR REMOVAL BY MICROBIAL DESULFURIZATION.

CHUNG, DR. K. E. SCIENCE CTR, ROCKWELL INT'L CORP., THOUSAND OAKS, CA 91360

SAMPLE # DATE(MM/DD/YR)

01120305 052586 A 20 LB BAG

01120306 052586 A 20 LB BAG

PROJECT TITLE:

NOT YET AVAILABLE

CLARKSON, R. UNIV. OF ILL., NOYES LAB, URBANA, IL 61801

SAMPLE # DATE(MM/DD/YR)

01180101 092383 URBANA, IL
02160201 092383
03160101 092383

PROJECT TITLE:

EPR & ENDOR STUDIES OF RADICALS IN COAL AND COAL LITHOTYPES

COLEMAN, D. ISGS, CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)

01180405 061784
02160514 050885
03160402 050885
04030610 050885

PROJECT TITLE:

BEHAVIOR OF SULFUR DURING DESULFURIZATION.

DEBARR, J. ISGS, 615 E. PEABODY DR., CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)

01180413 071685
03160409 071685

PROJECT TITLE:

CHAR DESULFURIZATION & COAL DEAGGLOMERATION USING THERMAL GRAVIMETRIC AND MICRO-DILATOMETER ANALYSES

OBJECTIVES: DETERMINATION OF DEVOLATIZATION AND SWELLING CHARACTERISTICS USING TGA AND TMA EQUIPMENT, AND THE REACTIVITY OF CHARs PRODUCED FROM THESE SAMPLES

DEBRUNNER, P. G. UNIV. OF ILL, 331 LOOMIS LAB, URBANA, IL 61801

SAMPLE # DATE(MM/DD/YR)

01180104 092383
01181406 010786
02160204 092383
03160104 092383

PROJECT TITLE:

THE DESULFURIZATION OF ILLINOIS COAL BY IN-SITU PREPARATION OF IRON CATALYSTS.

RESULTS: (1) THE ASIM ASSAY FOR PYRITE IS NOT RELIABLE.
(2) PYRITE OXIDATION TO SOME FORM OF IRON OXIDE IS A SERIOUS PROBLEM IN COALS THAT ARE NOT STORED UNDER STRICTLY ANAEROBIC CONDITIONS. (3) IN THE SAMPLES OF THE ILLINOIS COAL BANK, SPECIFICALLY THE FRACTION OF IRON OXIDES INCREASES SUBSTANTIALLY AT THE EXPENSE OF PYRITE OVER THE LAST TWO YEARS.

DUGAN, P. OHIO STATE UNIV., 484 W. 12TH AVE., COLUMBUS, OH 43210

SAMPLE # DATE(MM/DD/YR)

02160307 010786

03160307 010786

PROJECT TITLE:

ENERGY DISPERSIVE X-RAY FOR PYRITE AND METALS

DUTY, R. CHEMISTRY DEPT, ILL. STATE UNIV., NORMAL, IL 61761

SAMPLE # DATE(MM/DD/YR)

03160107 092385

03160108 092385

03160109 092385

PROJECT TITLE:

ORG. S. REACTIONS, CARBOXYLATION & PROTICAPROTIC SOLVENTS

EHRLINGER, HANK ISGS, CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)

01181600 062383

01181500 062383

01180900 071784 USED BY MIKE BUCKENTIN FOR STEM WORK

01171600 062383

01171500 062383

02151515 070683

02151600 070683

02161500 070683

02161616 070683

03151400 072683

03151500 072683

03151600 072683

03161400 072683

03161500 072683

03161600 072683

04030606 070683 2-1 LB BAGS 6,7

04050300 070683 1-20 LB BAG

04050102 072683 14-1 LB BAGS 2-15

04050102 072683 12-1 LB BAGS 2-7, 10-12, 14-16

04010200 072683 2-20 LB BAGS 2,3

04010102 072683 11-1 LB BAGS 2,3,4,7,8,9,10,13,14,15,16

04030102 072683 11-1 LB BAGS 2,3,4,7,8,9,10,13,14,15,16

04030606 072683 1-1 LB BAG

PROJECT TITLE:

FINE COAL CLEANING BY AGGREGATE FLOTATION

OBJECTIVES: DEVELOP AND OPTIMIZE THE ISGS AGGREGATE FLOTATION
PROCESS FOR CLEANING SULFUR AND ASH FROM FINELY CRUSHED COAL.

FROST, J. K. IGS, 615 E. PEABODY DR., CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)

01180407 061784
01180408 061784
04030605 061784 1-1 LB BAG

PROJECT TITLE:

SECONDARY REFERENCE STANDARDS FOR THE ANALYTICAL CHEMISTRY SECTION.

OBJECTIVE: COAL BANK SAMPLES #1 AND #4 HAVE BEEN ADOPTED FOR USE AS
SECONDARY REFERENCE SAMPLES. THEY WILL BE REPEATEDLY ANALYSED OVER
A LONG PERIOD OF TIME FOR MAJOR, MINOR AND TRACE ELEMENTS.

GIDASPOW, D. CHEM. ENG. DEPT., RM. 105PH, IIT CENTER, CHICAGO, IL 60616

SAMPLE # DATE(MM/DD/YR)

04081000 031886
04081500 031886

PROJECT TITLE:

DESULFURIZATION OF ILLINOIS COAL IN AN ELECTROFLUIDIZED BED.

RESULTS: AN EXPERIMENT WAS DONE WITH ILLINOIS #2 COAL OF 75 MICRON
AVERAGE PARTICLE SIZE HAVING 5.2% PYRITES. WITH 12000 VOLTS
IN AN ELECTROFLUIDIZED BED THEY WERE ABLE TO REDUCE PYRITES TO 3.33%
IN THE FIRST RUN.

GOECKNER, N. A. WESTERN IL UNIV., CURRENTS HALL 438A, MACOMB, IL 61455

SAMPLE # DATE(MM/DD/YR)

01180411 010985
02160508 010985

PROJECT TITLE:

THE CATALYTIC CONVERSION OF ILLINOIS COAL TO LIQUID PRODUCTS.

GRAFF, R. CHEM. ENG. DEPT., CITY COLLEGE, NEW YORK, NY 10031

SAMPLE # DATE(MM/DD/YR)

01180301 092184
01180311 092184
01180313 092184
01180314 092184
03160308 092184
03160311 092184
03160313 092184

PROJECT TITLE:

STEAM PRETREATMENT OF COAL.

HACKLEY, K. ISGS, 615 E. PEABODY DR., CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)

01180402 120385
01180403 120385
01180404 120385
01180410 120385
01180416 120385
03160401 120385
03160403 030885
03160412 030885

PROJECT TITLE:

BEHAVIOR OF SULFUR DURING DESULFURIZATION (ISOTOPE)

HAGY, JOHN DRAINSWERKE INC., 801 SWEET GUM RD., PITTSBURGH, PA 15243

SAMPLE # DATE(MM/DD/YR)

04030700 1-20 LB BAG

PROJECT TITLE:

STIRRED BALL MILL GRINDING TESTS

NOTE: THEY MANUFACTURE MACHINES USED TO GRIND COAL.

HOWELL, WAYNE CHEMICAL ENG. DEPT., 125 RAL, UNIV. OF ILL. URBANA 61801

SAMPLE # DATE(MM/DD/YR)

03141100 031186 1-20LB BAG

PROJECT TITLE:

STUDY OF ATTRITION IN FLUIDIZED BED PYROLYSIS

HUGHES, R. ISGS, 615 E. PEABODY DR., CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)

01180305 042584
02160504 042584
03160314 042584
04070109 042584 1-1 LB BAG

PROJECT TITLE:

CARBON MONOXIDE/ETHANOL DESULFURIZATION.

OBJECTIVE: IDENTIFY THE AFFECTS OF MINERAL IMPURITIES ON THE DESULFURIZATION PROCESS.

IGNASIAK, DR. B. INTERIM HIGH PRESSURE FAC., 1901 5TH ST., NISKU, ALB., CANADA

SAMPLE # DATE(MM/DD/YR)

01120600 052086 A 20 LB BAG
01120500 052086 A 20 LB BAG

PROJECT TITLE:

NOT YET AVAILABLE

JEPSON, W. P. UNIV. OF ILL., 207 ROGER ADAMS LAB., URBANA, IL 61801

SAMPLE # DATE(MM/DD/YR)

03I61000 030585

PROJECT TITLE:

SPRAYING OF COAL/OIL AND COAL/WATER SLIMES

JERGER, D. IGT, 3424 S. STATE ST., CHICAGO, IL 60616

SAMPLE # DATE(MM/DD/YR)

01180107 092383
01180108 092383
01180109 092383

PROJECT TITLE:

DESULFURIZATION OF COAL IN ELECTROFLUIDIZED BED.

CONTACT: DR. D. GIDASPOW: CHEM. ENG., IIT CENTER, CHICAGO, IL 60616

JOHNSON, W. UNIV. OF VICTORIA, VICTORIA, BC (CANADA)

SAMPLE # DATE(MM/DD/YR)

01180316 092184
02160509 050885
03160315 092084

KRIER, H UNIV. OF ILL., 214 MECH. ENG. BLDG., URBANA, IL 61801

SAMPLE # DATE(MM/DD/YR)

01140900 110185 8-20LB. BAGS 09-16 (200 LBS)
03130000 092185 400 LBS.

PROJECT TITLE:

STUDIES OF SO₂ REMOVAL DURING PULVERIZED COAL COMBUSTION BY
INJECTING LIMESTONE.

OBJECTIVE: DETERMINE OPTIMUM MIXTURE RATIOS, MIXING TIMES,
PARTICLE SIZES AND TEMPERATURE FOR THE CAPTURE OF SULFUR
OXIDES THROUGH LIMESTONE INJECTION.

KWANG, E. C. ROCKWELL INT. CORP. 1049 BOX 1085, THOUSAND OAKS, CA 91360

SAMPLE # DATE(MM/DD/YR)

01181401 100285

PROJECT TITLE: CHEMICAL-STRUCTURAL CHARACTER. USING NaOH/ETHANOL/H₂O REACTIONS
NOTE: CONTACT DR. K. CHUNG AT ROCKWELL.

MILLER, K. ISGS, 615 E. PEABODY DR., CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)

04031301 010786 10 LB. SAMPLE, 1-B BAGS.

PROJECT TITLE:

MICROBIAL DESULFURIZATION OF COAL.

MIRZA, IQBAL ISGS, 615 E. PEABODY DR., CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)

01181300 062685

PROJECT TITLE:

FLUIDIZED BED PYROLYSIS & CHAR DESULFURIZATION

MUCHMORE, C. SOUTHERN IL UNIV., CHEM. ENG., CARBONDALE, IL 62901

SAMPLE # DATE(MM/DD/YR)

01130000 041885 400 LBS.
01170100 081283 14-20 LB. BAGS 01-14
02150300 081283 12-20 LB. BAGS 03-14
03150200 072683 12-20 LB. BAGS 02-13

PROJECT TITLE:

SUPERCritical EXTRACTION OF SULFUR

NARAYAN, D. R. PURDUE UNIV., POTTER BLDG, WEST LAFAYETTE, IN 47907

SAMPLE # DATE(MM/DD/YR)

01180308 111484
01120800 052086 A 20 LB BAG

PROJECT TITLE:

COAL STRUCTURE AND REACTIVITY USING K-CROWN ETHER REAGENT

GIONY, L. 144 MECH ENG., UNIVERSITY OF ILLINOIS, URBANA, IL 61801

SAMPLE # DATE(MM/DD/YR)

02161300 052586 A 20 LB BAG

PROJECT TITLE:

DESULFURIZATION USING STEAM AT 700 DEG. C.

SERIO, MICHAEL A. ADV. FUEL RESEARCH, 87 CHURCH, EAST HARTFORD, CT 06108

SAMPLE # DATE(MM/DD/YR)

01180409 050885
01180414 050885
02160507 050885
02160510 050885
04030612 050885 2-1 LB BAGS 12, 14

PROJECT TITLE:

CHEMICAL AND PHYSICAL DEVELOPMENT OF CHAR PARTICLES DURING
DEVOLATILIZATION.

OBJECTIVE: WILL PROVIDE ACCURATE PREDICTIONS FOR THE THERMAL, OPTICAL,
PHYSICAL, AND REACTIVE PROPERTIES OF CHARs AS THEY DEVELOP DURING
DEVOLATILIZATION UNDER CONDITIONS TYPICAL OF GASIFIER OPERATION.

SMITH, CARL J. WV GEOLOGICAL SURVEY, PO BOX 879, MORGANTOWN, WV 26507

SAMPLE # DATE(MM/DD/YR)

01000000 061586
02000000 081586
04000000 061586

PROJECT TITLE:

ASH FUSION STUDY OF WEST VA

TO DEVELOP EQUATIONS TO PREDICT ASH FUSION TEMPERATURE FROM OTHER KNOWNs;
E.G., ASH/TOTAL SULFUR/PYRITIC SULFUR. WE WANT TO LOOK AT COAL FROM
INTERIOR BASIN VS OUR MODEL.

SOD, S. L. UNIV. OF ILL., 123 MECH. ENG. BLDG, URBANA, IL 61801

SAMPLE # DATE(MM/DD/YR)

01180200 092383
01181000 071784
02150100 072783
02160100 072783
02160600 071784
03160200 092383
01120800 011285

PROJECT TITLE:

STEAM ENHANCED OXIDATIVE DESULFURIZATION

RESULTS: AN EXPERIMENT PERFORMED WITH HERRIN NO. 6 COAL, ACHIEVED SULFUR
REMOVAL UP TO 65% OF TOTAL SULFUR IN HERRIN NO. 6 COAL.

RAPP, DAVID ISGS, 615 E. PEABODY DR., CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)

04031600 010786 20-LB SAMPLE
04030500 010786 20-LB SAMPLE
04031309 010786 10-LB SAMPLE, BAGS 9-16

PROJECT TITLE:

AGGREGATE FLOTATION AND FINE COAL CLEANING PROCESS.

OBJECTIVE: DEVELOP AND OPTIMIZE THE ISGS AGGREGATE FLOTATION PROCESS.

RAUCHFUSS, T. UNIV. OF ILL., 335 NOYES LAB., URBANA, IL 61801

SAMPLE # DATE(MM/DD/YR)

01180102 092383
02160202 092383
03160102 092383
03160410 030885

PROJECT TITLE:

MOLECULAR MODELS FOR DESULF. CATALYSIS

REUTHER, JAMES J. BATTELLE, 505 KING AVE., COLUMBUS, OH 43201-2693

SAMPLE # DATE(MM/DD/YR)

01140100 061785 8-20 LB. BAGS 01-08

PROJECT TITLE:

EVALUATION OF CALCIUM IMPREGNATED COAL AS A FUEL FOR TURBINE COMBUSTORS
SULFUR CAPTURE BY RAW COALS AND CA-IMPREGNATED COALS FROM ILL. #6 IS
INDEPENDENT OF SULFUR FORM, IE, ORGANIC VS. INORGANIC SULFUR.

SCHARFF, M. F. SCI. APPL'TN INT'L, 10401 ROSELLE, SAN DIEGO, CA 92121

SAMPLE # DATE(MM/DD/YR)

03160408 082585
04030615 082585 1-1 LB BAG

PROJECT TITLE:

REDUCTION OF PHOSPO-GYPSUM FROM FLA.. PHOSPHATES TO PRODUCE CONCENTRATED
SULFUR.

RESULTS: COAL PROVIDES HEAT AND REDUCTANT GASES TO CONVERT CASO₄ TO A
SULFUR PRODUCT. RESULTS ARE COMPLETED FOR COALS FROM OHIO, E. KY, AND
IBCSP #3. ALL COALS GAVE CONVERSION TIMES WELL LESS THAN 1 MINUTE, BUT
THE ILLINOIS COAL SAMPLE WAS THE BEST.

STEPHENSON, M. ISGS, 615 E. PEABODY DR., CHAMPAIGN, IL 61820

SAMPLE # DATE(MM/DD/YR)

01180303 110883 6-4LB. BAGS 3, 4, 6, 7, 9, 10
01180401 110883 4-4 LB. BAGS 1, 6, 11, 15
01120100 012086
02160700 110883
03160300 110883
03160404 110883 7-4 LB. BAGS 4-6, 11, 14-16
03160900 072084
03160800 012086

PROJECT TITLE:

LOW TEMPERATURE CHARRING.

RESULTS: HIGH SULFUR COAL SAMPLES WERE PYROLIZED TO REDUCE THE SULFUR CONTENT FROM ABOUT 4% TO 2.8% AND THEN TREATED WITH HYDROGEN TO REDUCE THE SULFUR CONTENT TO 1% OR LESS.

STOCK, L. M. DEPT. OF CHEMISTRY, UNIV. OF CHICAGO, CHICAGO, IL 60637

SAMPLE # DATE(MM/DD/YR)

01180105 092383 4 LB. BAGS 5, 6
02160205 092383 4 LB. BAGS 5, 6
03160105 092383 4 LB. BAGS 5, 6

PROJECT TITLE:

THE NATURE AND CHEMISTRY OF THE SULFUR COMPOUNDS IN ILLINOIS COAL. ELEMENTAL SULFUR, PRESENT IN WEATHERED SAMPLES OF THE ILLINOIS COALS, IS ABSENT IN THE SINGLE PRISTINE SAMPLE NOW AVAILABLE. OXIDIZED ORGANIC SULFUR COMPOUNDS ARE ALSO PRESENT IN THE WEATHERED COALS. NEITHER ALIPHATIC THIOLS NOR AROMATIC THIOLS APPEAR TO BE PRESENT IN THE ILLINOIS COALS. HENCE, WE POSTULATE THAT THE PRINCIPAL SULFUR-CONTAINING ORGANIC CONSTITUENTS ARE APPORTIONED AMONG DIARYL SULFIDES, ARYL ALKYL SULFIDES, AND HETEROCYCLIC COMPOUNDS. IN AN EARLIER STUDY, WE ESTABLISHED THAT THE SULFUR COMPOUNDS THAT ARE PRESENT IN ILLINOIS COALS ENHANCE THEIR LIQUEFACTION REACTIONS SIGNIFICANTLY. DESULFURIZATION REACTIONS USING REDUCTIVE, ANION-RADICAL CHAIN REACTIONS AND CATION-RADICAL PROCESSES ARE ALSO UNDER INVESTIGATION.

TWO QUITE DIFFERENT REACTION SYSTEMS HAVE BEEN FOUND FOR THE CLEAVAGE OF CARBON-SULFUR BONDS.

STOICOS, T. UNIVERSAL OIL PRODUCTS, PLAINES, IL

SAMPLE # DATE(MM/DD/YR)

04070200 29 LB BAG

PROJECT TITLE:

NOT KNOWN.

STOICOS IS NO LONGER WITH UNIVERSAL OIL PRODUCTS; NO CONTACT AVAILABLE.

UPADHYA, K. BOX 4348, CHEM. ENG., UNIV. OF ILL., CHICAGO, IL 60680

SAMPLE # DATE(MM/DD/YR)

01120401 040286 15 1-LB BAGS 01-15
02160901 040286 15 1-LB BAGS 01-15
03141501 040286 15 1-LB BAGS 01-15
04081301 040286 15 1-LB BAGS 01-15

PROJECT TITLE:

MECHANISMS AFFECTING SULFUR REMOVAL FROM COAL IN H₂ OR H₂O+H₂
ENVIRONMENT.

WERT, C. UNIV. OF ILL., 217 MET. DEPT. URBANA, IL 61801

SAMPLE # DATE(MM/DD/YR)

01180103 092383
02160203 092383
03160103 092383

PROJECT TITLE:

MICROCHEMISTRY OF COAL AND ORGANIC S BY SCAN TRANS ELECTRON MICROSCOPY.

WHAM, ROBERT OAK RIDGE NAT. LAB, BLDG 4501, MS 217, OAK RIDGE TN 37831

SAMPLE # DATE(MM/DD/YR)

01120306 052086
01120308 052086
01120711 052086

PROJECT TITLE:

NOT YET AVAILABLE

YOUNG, JOHN E. ARGONNE NAT'L LAB., 9700 CASS, BLDG 205, ARGONNE, IL 60439

SAMPLE # DATE(MM/DD/YR)

?SAMPLE #

